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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of — Atty. Docket

ANNA PELAGOTTI ET AL. — PHNL 010022

Serial No.: 10/046,626 — Group Art Unit: 2613

Filed: January 14, 2002 — Examiner: A.C. Wong

Title: REDUCING HALO-LIKE EFFECTS IN MOTION-COMPENSATED INTERPOLATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Enclosed is an original copy of an Appeal Brief in the above-identified patent application.

Please charge the fee of $500.00 to Deposit Account No. 14-1270.

Respectfully submitted,

By [signature]
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CERTIFICATE OF MAILING

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On Sept. 28, 2005
(Date of Mailing)

By Burnett James
(Signature)

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REDUCING HALO-LIKE EFFECTS IN MOTION-COMPENSATED INTERPOLATION

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Sir:

APPEAL BRIEF

This is an appeal from the Examiner of Group 2613 finally rejecting claims 1, 4, 6 and 7 in this application.

(i) Real Party in Interest

The real party in interest in this application is KONINKLIJKE PHILIPS ELECTRONICS N.V. by virtue of an assignment from the inventors recorded on June 11, 2002, at Reel 12989, Frames 636-638.

(ii) Related Appeals and Interferences

There are no other appeals and/or interferences related to this application.

(iii) Status of the Claims

Claims 1, 4, 6 and 7 stand finally rejected. Claims 2, 3 and 5 have been allowed.

(iv) Status of Amendments

There was one (1) Amendment filed on July 13, 2005, after final rejection on May 20, 2005, this Amendment having been entered by the Examiner.

(v) Summary Of Claimed Subject Matter

The subject invention relates to motion-compensated interpolation of an image signal containing successive images, each image having groups of pixels. Motion vectors are generated between groups of pixels in one image and corresponding groups of pixels in a successive image, and interpolated results are obtained as a function of the motion vectors, an interpolated image being obtained by averaging the interpolated results, this interpolated image being temporally located between the successive images.

Appellants have found that when using this method, the area of halo-effect in the interpolated image is increased, wherein the halo-effect is due to impairments (blurring and/or magnifying lens effect) mainly occurring at the boundaries of moving objects, due to incorrect motion vectors and/or an incorrect interpolation strategy in the motion compensated interpolated images.

The subject invention seeks to reduce the area of halo-effect in interpolated images. To that end, as claimed in claims 1 and 6, the subject invention includes "generating motion vectors, each motion vector corresponding to a group of pixels of one image, between a group of pixels of said one image and a second group of pixels of another image in the data-signal". This is shown in Fig. 3 and described in the specification on page 8, line 32 to page 9, line 2, in which in block 18, a first motion vector is calculated for each group of pixels while a number of second motion vectors of surrounding groups of pixels are assigned to each group of pixels. Next, as claimed in claims 1 and 6, the subject invention includes "generating interpolated results as a function of these motion vectors". This is shown in Fig. 3 and described in the specification on page 8, lines 30-31, and on page 6, line 23 to page 7, line 14, in which block 16 receives the motion vectors from block 18 (via blocks 20.m) and the corresponding pixels from the input data-signal, and calculates the interpolated results. The subject invention further includes "estimating the reliability of each motion vector corresponding to a particular group of pixels". This is shown in Fig. 3, and described in the specification on page 9, lines 2-4, in which blocks 20.m calculate the reliability of each of the motion vectors. Now, according to claims 1 and 6, the subject invention includes "calculating weights as a function of the reliability of the motion vectors". As noted in the

specification on 2, lines 12-15, and on page 7, lines 16-18, a relative weight corresponding to each interpolation result is calculated on the basis of the reliability of the motion vector, this calculation be carried out in block 16. Finally, the invention includes "generating an interpolated luminous intensity of a group of pixels for an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results". This is described in the specification on page 2, lines 16-31, page 7, lines 18-23, and page 8, lines 31-32, in which block 16 also calculates the interpolated luminous intensities.

Claim 4 indicates "the generation of interpolated luminous intensities is only performed in those parts of the images of the data-signal where edges in the motion vector field of the images are located". This is described in the specification on page 8, lines 1-6.

(vi) Grounds of Rejection to be Reviewed on Appeal

Whether the invention, as claimed in claims 1, 4, 6 and 7, is anticipated, under 35 U.S.C. 102(b), by U.S. Patent 5,412,435 to Nakajima.

(vii) Arguments

The Nakajima patent discloses interlaced video signal motion compensation prediction system in which motion vectors are

generated for selected groups of pixels in one image and corresponding groups of pixels in a second image. These motion vectors are applied to a selector 43 which selects one of the motion vectors in response to a comparison by a comparator 42.

The subject invention, as claimed, includes "generating motion vectors, each motion vector corresponding to a group of pixels of one image, between a group of pixels of said one image and a second group of pixels of another image in the data-signal", "generating interpolated results as a function of these motion vectors", "estimating the reliability of each motion vector corresponding to a particular group of pixels", "calculating weights as a function of the reliability of the motion vectors", and "generating an interpolated luminous intensity of a group of pixels for an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results".

As noted in MPEP 2131, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Further, "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Appellants submit that while Nakajima arguably discloses generating motion vectors, and estimating the reliability of each motion vector (note that the motion vectors from the motion vector estimators 31-3n include prediction error signals E1-En), Nakajima neither discloses or suggests "calculating weights as a function of the reliability of the motion vectors", "generating interpolated results as a function of these motion vectors", and "generating an interpolated luminous intensity of a group of pixels for an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results".

With regard to the limitation "calculating weights as a function of the reliability of the motion vectors", in Nakajima, the reliability of the motion vectors V1 ... Vn are the prediction error signals E1 ... En. According to Nakajima at col. 11, lines 21-24, these prediction error signals E1 ... En are given handicap values (weighted) corresponding to the number of vectors according to coded information CI. Hence, the weighting in Nakajima is not a function of the reliability of the motion vectors, but rather corresponds to a number of vectors.

The Examiner states:

> "In fig. 20, Nakajima discloses the inputted motion vectors V1 ... Vn to element 43, the selection, is done to process or interpolate the results of the motion vectors V1 ... Vn obtained via the motion vector estimators 31 ... 3n. Finally, at the end of the process or interpolation, whereby element 43 considers the information from elements 41 and 42 that incorporates the data of the weights E1 ... En, the

> best processed or interpolated results are outputted from element 43. Thus, Nakajima discloses "generating interpolated results as a function of these motion vectors".

However, according to Nakajima at col. 11, lines 2-10, the values V1 ... Vn are motion vectors, while E1 ... En are block prediction errors. At col. 11, lines 19-29, Nakajima states:

> "Prediction errors E1, E2 . . . , En output from the 1-, 2-, . . . , n-vector motion estimators 31, 32 . . . , 3n are input to a pre-processor 41, and the individual prediction errors are given handicap values corresponding to the number of vectors according to coded information CI. The signals given the handicap values are compared in a comparator 42 for selection of one of them for each block, and a selection flag ZM indicative of the selected signal is output. According to the result obtained in the comparator 42, a selector 43 effects motion vector selection to output motion vector ZV."

It should be clear from this passage that the block prediction errors E1 ... En are weighted (given handicap values) in the pre-processor 41, and the weighted block prediction errors are then compared in the comparator 42 for selecting one of the block prediction errors E1 ... En. The selected block prediction error is then applied to the selector 43 to select the output motion vector ZV from the applied motion vectors V1 ... Vn. Hence, contrary to the Examiner's statements, there is no interpolation. Rather, there is a selection of one of the block prediction errors E1 ... En and the selection of one of the motion vectors V1 ... Vn based on the selected block prediction error.

The Examiner then states:

> "Also in Nakajima's fig. 20, the results that are outputted from element 43, clearly are obtained by incorporating the weights E1 ... En, i.e., luminous intensity, from elements 31 ... 3n. The weights E1 ... En are inputted to elements 41 and 42 where the data is processed or interpolated to generate interpolated data to send to element 43 that takes the weighted data E1 ... En into consideration, and that element 43 yields the best processed or interpolated results for the generation of interpolated luminous intensity, ie. Weighted data, of a group of pixels for an interpolated image. Weighted data E1 ... En are obtained from interpolated luminous intensity or the luminance differences to determine the differences in motion in order to properly determine the best representative luminous intensity of the image data. Thus, Nakajima teaches "generating an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results".

This statement of the Examiner is incredible, especially when compared to that which is specifically stated in Nakajima (above). Appellants submit that the sole intent of Nakajima is to generate motion vectors with the smallest prediction errors.

Nakajima mentions interpolation in describing the inter-field interpolated motion estimator 14 (Figs. 4, 13), intra-field interpolation circuit 22 (Figs. 7, 9, 11, 16), intra-frame interpolation circuit 28 (Fig. 14). However, in each case, these circuits receive the input and reference block data (10 and 11), and are used to generate motion vectors. This is just the opposite from the subject invention as claimed, to wit, "generating interpolated results as a function of these motion vectors" and "generating an interpolated luminous intensity of a group of pixels

for an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results".

Based on the above arguments, Appellants believe that the subject invention is neither anticipated nor rendered obvious by the prior art and is patentable thereover. Therefore, Appellants respectfully request that this Board reverse the decision of the Examiner and allow this application to pass on to issue.

Respectfully submitted,

by
Edward W. Goodman, Reg. 28,613
Attorney

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On Sept 28, 2005
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(viii) Appendix

CLAIMS ON APPEAL

1. (Previously Presented) A method of motion-compensated interpolation of a data-signal, said data-signal comprising successive images wherein each image comprises groups of pixels, the method comprising the steps of:

generating motion vectors, each motion vector corresponding to a group of pixels of one image, between a group of pixels of said one image and a second group of pixels of another image in the data-signal;

generating interpolated results as a function of these motion vectors;

estimating the reliability of each motion vector corresponding to a particular group of pixels;

calculating weights as a function of the reliability of the motion vectors; and

generating an interpolated luminous intensity of a group of pixels for an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results.

2. (Previously Presented) A method of motion-compensated interpolation of a data-signal, said data-signal comprising

successive images wherein each image comprises groups of pixels, the method comprising the steps of:

generating motion vectors, each motion vector corresponding to a group of pixels of one image, between a group of pixels of said one image and a second group of pixels of another image in the data-signal;

generating interpolated results as a function of these motion vectors;

estimating the reliability of each motion vector corresponding to a particular group of pixels;

calculating weights as a function of the reliability of the motion vectors; and

generating an interpolated luminous intensity of a group of pixels for an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results, wherein the interpolated luminous intensity of a group of pixels is calculated according to:

$$I^{k+\Delta}(\vec{x}) = \left(\sum_{m=1,\ldots,M} \{w^k_m(\vec{x}) * i^{k+\Delta}_m(\vec{x})\}\right) / \sum_{m=1,\ldots,M} \{w^k_m(\vec{x})\}, \quad \textbf{(A)}$$

wherein $I^{k+\Delta}(\vec{x})$ is the interpolated luminous intensity of the group of pixels of an interpolated image $F^{k+\Delta}$, wherein the location of the group of pixels in the image is defined by the integer two-dimensional vector $\vec{x}$ and where the real value Δ defines the place

of the interpolated image $F^{k+\Delta}$ in the image sequence F^n, $n=1,2,\ldots,k,k+1,\ldots,N$, wherein $\sum_{m=1,..,M}\{.\}$ is a summation from 1 to M over its argument $\{.\}$ and where $w^k{}_m(\vec{x})$ is a weight corresponding to the m^{th} interpolation result $i^{k+\Delta}{}_m(\vec{x})$:

$$i^{k+\Delta}{}_m(\vec{x}) = median\{\ (I^k(round\{\vec{x} - \Delta * \vec{D}^k_m(\vec{x})\}),\ (I^k(\vec{x}) + I^{k+1}(\vec{x}))/2),\ (I^{k+1}(round\{\vec{x} + (1-\Delta) * \vec{D}^k_m(\vec{x})\})\ \}, \qquad \textbf{(B)}$$

wherein median{.} is a function which gives the median value of its input arguments and round{.} is a function which gives the nearest integer value to each component of its input argument, and wherein $I^k(\vec{x})$ is a luminous intensity of the group of pixels at location $\vec{x}$ of the image F^k and wherein $\vec{D}^k_m(\vec{x})$ is the m^{th} two-dimensional integer motion vector, which is normalized between two successive images, of the M motion vectors which correspond to the group of pixels at location $\vec{x}$ and wherein the weight $w^k{}_m(\vec{x})$ is a function of the reliability of the motion vector $\vec{D}^k_m(\vec{x})$.

3. (Previously Presented) The method as claimed in claim 2, wherein the reliability of the motion vector $\vec{D}^k_m(\vec{x})$ is a function of the difference between the luminous intensities $I^k(\vec{x})$ and

$I^{k+1}(\bar{x}+\vec{D}_m^k(\vec{x}))$ and wherein the reliability is also a function of the relative frequency of occurrence of $\vec{D}_m^k(\vec{x})$ in the neighborhood of the location $\vec{x}$ in the image F^k.

4. (Previously Presented) The method as claimed in claim 1, wherein the generation of interpolated luminous intensities is only performed in those parts of the images of the data-signal where edges in the motion vector field of the images are located.

5. (Previously Presented) A method of motion-compensated interpolation of a data-signal, said data-signal comprising successive images wherein each image comprises groups of pixels, the method comprising the steps of:

generating motion vectors, each motion vector corresponding to a group of pixels of one image, between a group of pixels of said one image and a second group of pixels of another image in the data-signal;

generating interpolated results as a function of these motion vectors;

estimating the reliability of each motion vector corresponding to a particular group of pixels;

calculating weights as a function of the reliability of the motion vectors; and

generating an interpolated luminous intensity of a group of pixels for an interpolated image by calculating, on the basis of these weights, a weighted average of the interpolated results, wherein the generation of interpolated luminous intensities is only performed in those parts of the images of the data-signal where edges in the motion vector field of the images are located, and wherein the method comprises a step of edge detection, wherein an edge in the motion vector field of image F^k is detected if at least one of the inequalities (C1) and (C2) is satisfied:

$$\|[\vec{D}_q^k(\vec{x}-\vec{K})]_1 - [\vec{D}_q^k(\vec{x}+\vec{K})]_1\| > \mathrm{T}, \quad \textbf{(C1)}$$

$$\|[\vec{D}_q^k(\vec{x}-\vec{K})]_2 - [\vec{D}_q^k(\vec{x}+\vec{K})]_2\| > \mathrm{T}, \quad \textbf{(C2)}$$

where q is a pre-determined integer value and wherein $\|.\|$ is a function which yields the absolute value of its input argument, $[.]_p$ is a function which yields the p^{th} component of its vector input argument, where T is a pre-determined fixed real value threshold and wherein $\vec{K}$ is a vector which is given with:

$$\vec{K} = (K_1;K_2)^T, \quad \textbf{(D)}$$

where K_1 and K_2 are integer values.

6. (Previously Presented) A device for motion-compensated interpolation of a data-signal, said data-signal comprising successive images wherein each image comprises groups of pixels, the device comprising:

means for generating motion vectors, each motion vector corresponding to a group of pixels of one image, between a group of pixels of said one image and a second group of pixels of another image in the data-signal;

means for generating interpolated results as a function of these motion vectors;

means for estimating the reliability of each motion vector corresponding to a particular group of pixels;

means for calculating weights as a function of the reliability of the motion vectors; and

means for generating interpolated luminous intensities of groups of pixels by calculating, on the basis of these weights, weighted averages of the interpolated results.

7. (Previously Presented) A picture signal display apparatus, comprising:

means for receiving a data-signal, which data-signal comprises successive images wherein each image comprises groups of pixels;

a device for motion-compensated interpolation of said data-signal, as claimed in claim 6;

means for generating at least one interpolated image on the basis of said interpolated luminous intensities; and

means for displaying the at least one interpolated image.

(ix) Evidence Appendix

There is no evidence which had been submitted under 37 C.F.R. 1.130, 1.131 or 1.132, or any other evidence entered by the Examiner and relied upon by Appellant in this Appeal.

(x) Related Proceedings Appendix

Since there were no proceedings identified in section (ii) herein, there are no decisions rendered by a court or the Board in any proceeding identified pursuant to paragraph (c)(1)(ii) of 37 C.F.R. 41.37.